Overview of Distributed Wind Turbine Projects

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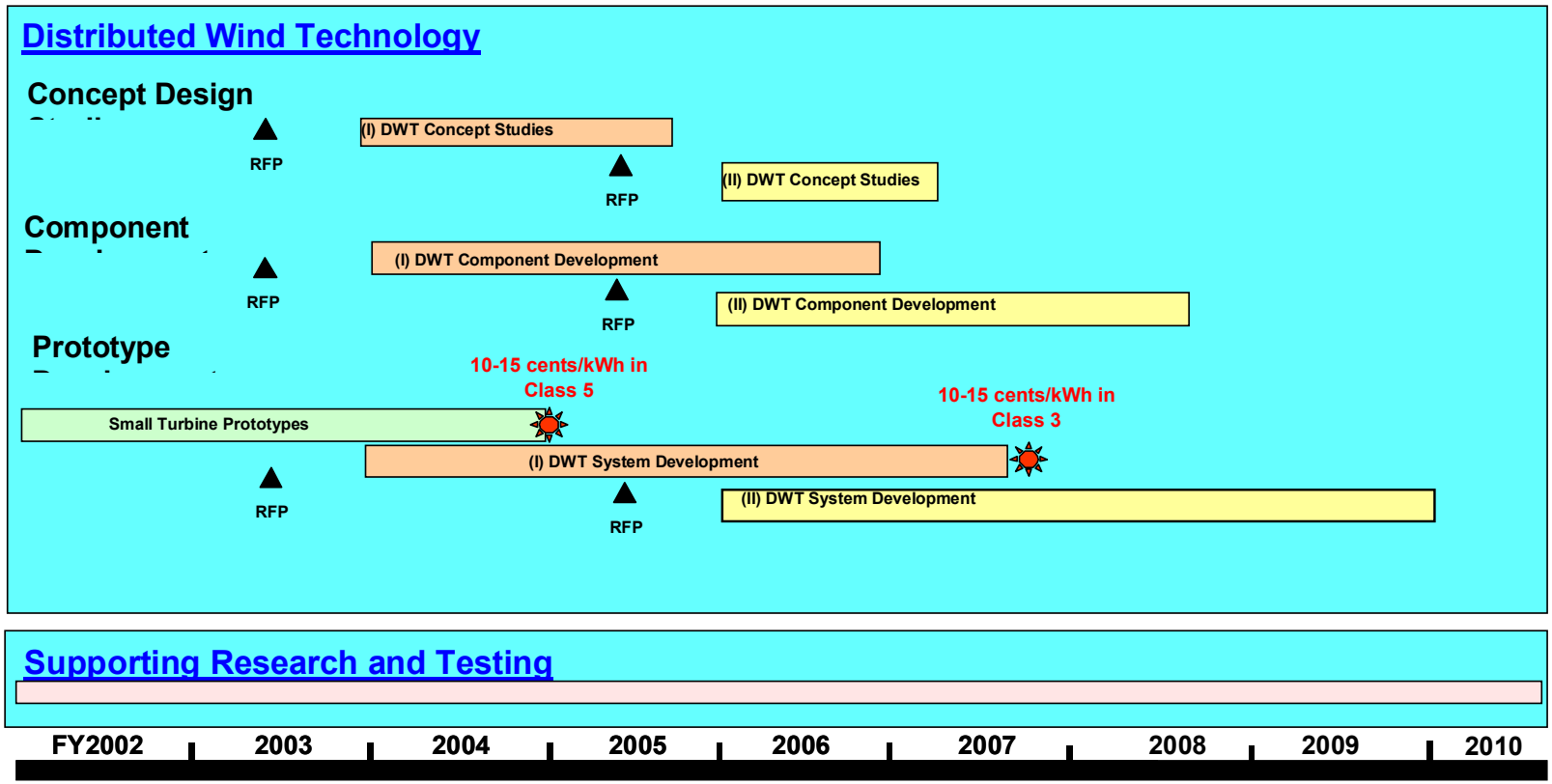
U.S. Department of Energy
Energy Efficiency and Renewable Energy

Multi-Year Technical Plan



FY05 DWT Budget

- DWT Technical Support - $200k
- DWT Enabling Research - $640k
  - Aeroacoustics Model Development
  - 3-D Stall Delay Modeling
  - SWRT Data Reduction and Analysis
- DWT Design Review and Analysis - $615k
- DWT Test Support - $785k
- DWT SR&T Subcontracts - $290k

FY05 Milestones

- *Joule Milestones – Dennis Lin*
  - *17410 –*
    - *Complete installation of 1.8 kW wind turbine at the NWTC in preparation for field testing. 12/31/04 (Q1 Joule Milestone)*
    - *Complete IEC Safety and Function Test on 1.8 kW wind turbine. 03/31/05 (Q2 Joule milestone)*
    - *Complete IEC acoustic and power performance tests on 1.8 kW wind turbine. 06/30/05 (Q3 Joule milestone)*
    - *Complete prototype testing of 1.8 kW Small Wind Turbine, finishing the IEC suite of tests for acoustics, power, duration, and safety. 09/30/05 (Q4 Joule milestone)*
  - *14987*
    - *Support DOE/GO Phase II RFP proposal evaluations. 08/31/05*
  - *17411*
    - *Complete subcontract awards. 09/30/05*

FY05 Milestones (cont.)

- *Joule Milestones – Dennis Lin*
  - *17406*
    - *Complete test section calibration and benchmark airfoil tests at VPI; report results in a conference paper or NREL TR. 01/31/05*
    - *Complete update of NREL's semi-empirical aeroacoustic prediction code; report results in a conference paper or NREL TR. 09/30/05*
    - *Complete Post-Stall Airfoil Characteristic Study; report results in a conference paper or NREL TR. 06/30/05*
    - *Complete final report on SWRT field test; report results in an NREL TR. 09/30/05*
  - *17407 - Document capability to use thermal imagery in the evaluation of DWT components. 11/30/04*
  - *17408 - Conduct Final Project Review for Southwest Windpower. 09/30/05*
  - *17408 - Review SWWP Installation Operating and Maintenance Manuals. 06/30/05*
  - *17408 - Support 3 DOE GO financial assistance project's design reviews. 03/31/05*

Goals of NREL project - Storm

- *CoE of $0.10/kWh @5.4 m/s*
- *Initial release price of $3,500 (turbine and tower)*
- *Integrated inverter*
- *>400 kWh/mo @ 5.4 m/s*
- *Enter production in 2nd quarter of 2005*

Storm design goals

- *Quiet enough not to be "noticed" (well below 5 db from background, no pure or sharp tones)*
- *Low wind speed enough that its rotation is the first sign of any breeze <2.5 m/s*
- *Tower and turbine blend into residential neighborhoods sufficiently so as not to not be generally noticed*
- *Tower and turbine conform to all standard local zoning restrictions – 10 meter free standing monopole*
- *Beautiful to mainstream aesthetics – not offensive to neighbors – Inspiring?*
- *Power cost design goal is less than typical utility rates without subsidies – ($0.08/khw at 5.4 m/s)*
- *Target power production is <400 kwh/mo at 5.4 m/s –Below any state average (CA is lowest at 430, San Diego is just 234 ($0.206/kWh), Tennessee is highest at 1303! National Avg. is about 900 kWh/mo -2002 data)*
- *High volume manufacturing - 5,000/month*

Major achievements of Storm design project

- *Stall control*
  - *No added cost*
  - *Quiet high wind speed operation*
  - *Leveling of power curve at desired level*
- *Rotor Cp of 0.46 on a small wind turbine*
- *COE competitive with conventional in a small wind turbine*
- *Slotless, high efficiency wind turbine alternator*
- *Integrated Inverter*

DOE/GO Financial Assistance Projects

	Total Project Cost	PoP
Abundant RE	$644,659	6/30/2005
Alaska Applied	$118,000	3/31/2005
Composite Engineering	$1,457,555	6/30/2006
GEC	$99,910	6/30/2005
Northern Power Systems	$2,046,881	9/30/2006
Princeton Power	$842,242	9/30/2005
Spellman High Voltage	$500,000	12/30/2004
TIAX	$99,977	9/30/2004
K. Wetzel & Co.	$363,000	3/31/2005
Windward Engineering	$1,069,707	9/30/2006

Indicates – have grant paperwork

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FY05 DWT Technical Support

Enter Employee:	WER52001	WER54100	WER54201	WER54202	WER54301	WER54302	WER54303
	DWT Tech. Support	DWT ER	DR&A DWT S/C	DR&A DWT GO	DWT Field Test	Storm Testing	RFV
	#14987	#17406	#17408	#17408	#17410	#17410	#17410
Adams, Jim						1.30	
Ashwill, Tom							
Bianchi, Gerry							
Butterfield, Charles	1.00		0.75	0.35			
Corbus, Dave		9.40					
Fingersh, Lee-Jay			0.25	0.50			
Forsyth, Trudy	3.50		0.50	3.75			
Gevorgian, Vahan							
Green, Jim	1.00		5.50	3.30			
Hughes, Scott						0.70	
Huskey, Arlinda					2.50	3.00	1.00
Jenks, Mike							
Krich, Abigail							1.00
Link, Hal			0.25	0.25	0.50	1.00	
Jimenez, Tony							
Jones, Perry							
Jonkman, Jason			0.50				
Meadors, Mark					1.00	4.50	0.50
Migliore, Paul	1.00	5.00	2.00	3.80			
Moriarty, Pat		3.00					
Muljadi, Eduard	0.50		1.00	0.70			
Newcomb, Charles	1.00			0.25		0.85	
Osgood, Rich						0.60	
Rumsey, Mark							
Sinclair, Karin							4.90
Tangler, James	1.00	8.50	1.00	1.30			
TOTAL	**9.00**	**25.90**	**11.75**	**14.20**	**4.00**	**11.95**	**7.40**

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Summary of DOE/GO Grant Support

	NREL Subcontracts						DOE/GO Financial As
	Bergey Windpower	Southwest Windpower	Alaska Applied Sciences	Abundant Renewable Energy	Composite Engineering	GEC	Northern Power Systems
Contracting Vehicle Type	Subcontract	Subcontract	Grant - Component	Grant - Preliminary Design	Grant - Component	Grant - Concept	Cooperative Agreement - Prototype
PoP	CRADA	12/30/2004	4/1/2005	6/30/2005	?	6/30/2005	9/30/2006
Type of Support							
Design Review and Analysis							
Alternator Design		⌘					⌘
Blade Design		⌘		⌘	⌘		
Blade Selection and Manufacturing							
Certification Planning and Documentation Review		⌘					⌘
Component sizing and advise							
Controller Design							⌘
Detailed Design Review	⌘	⌘			Mar-05		May-05
Small Dynamometer Tests							⌘
Electrical System and Interconnect		⌘					⌘
FEA							
Final Design Review		⌘			Aug-05	Jun-05	Jan-06
Final Report Review			Apr-05				
Flutter Analysis							
Furling Analysis	⌘						
Lightning Protection		⌘					⌘
Pitch System							
Power Electronics		⌘					⌘
Preliminary Design Review	⌘	⌘		Feb-05			Nov-04
Subcontract Kickoff Meeting	⌘	⌘		Dec-03	Apr-04		Jun-03
Structural Blade Tests					⌘		
Test/instrumentation/DAS advise							⌘
Test Planning							⌘
Supporting Research and Testing							
Code Development							
Aeroacoustics		⌘					⌘
Aerodynamics		⌘		⌘			
Data Processing and Analysis							
Inflow Modeling	⌘	⌘					
Loads and Dynamics	⌘	⌘		⌘			⌘
Field Tests	⌘	⌘					⌘
Structural Tests	⌘	⌘	⌘	⌘	⌘		
SNL Inverter Tests							
Wind Tunnel Tests	⌘	⌘		⌘	⌘		

Future DWT Work

- On October 20 & 21 gave detailed overview of DWT Projects to Dennis Lin/Keith Bennett
- Phase II RFP
  - Concept Studies and Component Development - DOE/GO grants
  - Prototype Development – NREL Subcontracts
- All Phase II RFPs will be released in FY05 & awarded in FY06
- Preliminary Phase III – FY09 – DWT Technology Development from 101 – 750 kW